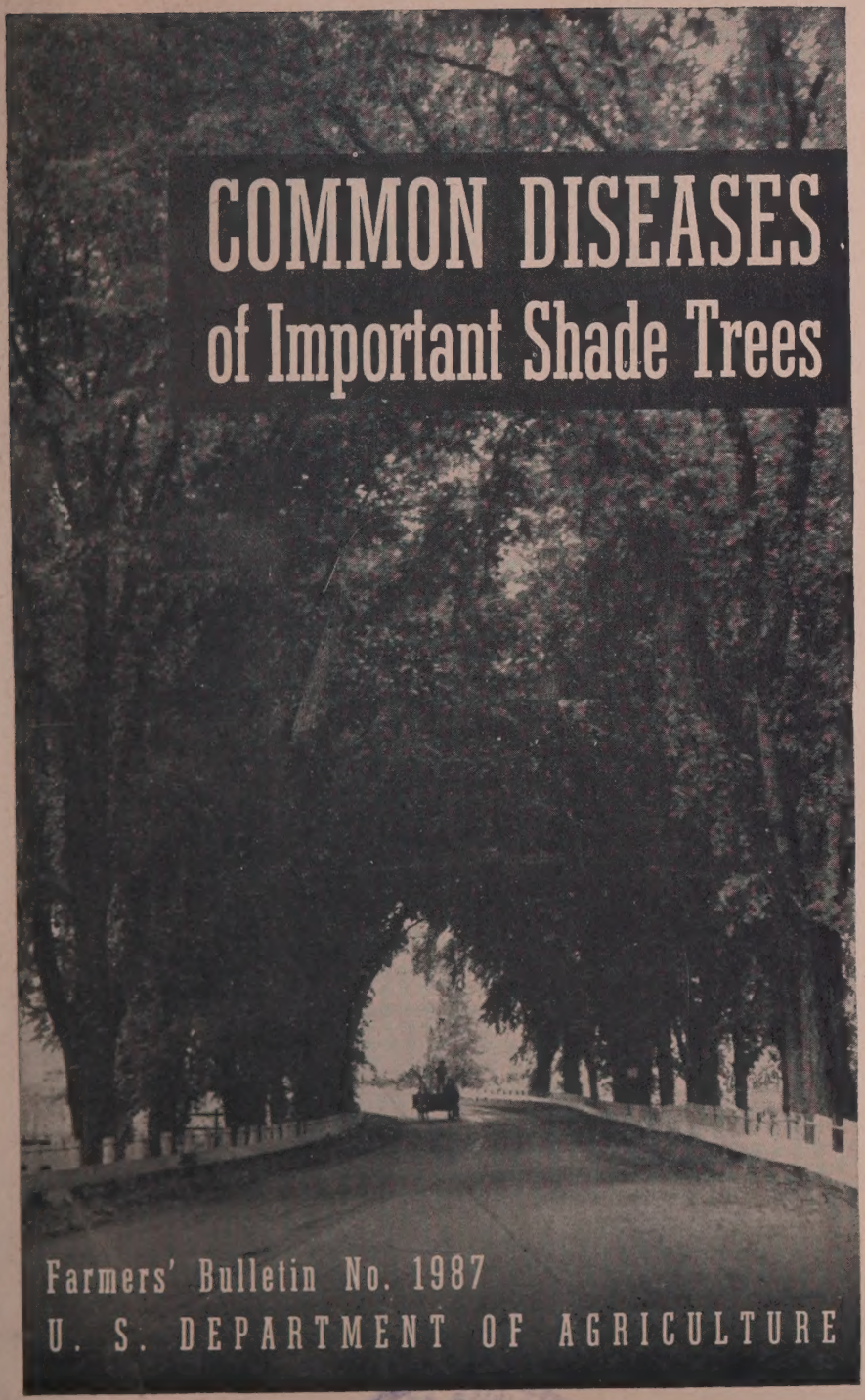
COMMON DISEASES of Important Shade Trees



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SHADE trees in the United States represent an investment estimated at more than $600,000,000. Great as it is, this figure is based only on economic considerations and fails therefore to express the aesthetic and sentimental regard we have for our trees. The value of the beauty and comfort they provide about our homes, in our parks, and on our streets and highways cannot be estimated in dollars.

Shade trees for many years may withstand adverse soil, moisture, and weather conditions to which they are not exposed in their natural forest surroundings. Continued poor environment or attacks by diseases or insects, however, often kill or disfigure the trees we value most. We can avoid or correct much of this loss by the timely use of suitable control or remedial measures.

The chief characteristics of each disease, as given in this bulletin, will assist the reader in determining the cause of his tree troubles. Accurate diagnosis of some diseases, however, calls for laboratory methods. State agricultural colleges will usually examine specimens sent to them, as also will the Division of Forest Pathology, United States Plant Industry Station, Beltsville, Md.

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COMMON DISEASES OF IMPORTANT SHADE TREES[1]

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CAUSES OF SHADE TREE DISEASES

SHADE tree diseases and failure of trees to thrive under all growing conditions to which they are exposed are caused by fungi, bacteria, viruses, and unfavorable conditions of soil and climate.

Fungi are plants, many of them microscopic. The plant body consists of threadlike filaments known as *hyphae*, which together comprise the *mycelium* that grows on or in affected trees. In many cases the mycelium produces various types of structures that bear reproductive bodies called spores.

[1] Cooperative investigations carried on by the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, and the Osborn Botanical Laboratory, Yale University.

Bacteria are microscopic plants. The forms that cause shade tree diseases are single-celled rod-shaped organisms.

Neither the bacteria nor the fungi contain the green coloring matter that enables ordinary plants to manufacture food in the presence of light. For this reason bacteria and fungi must obtain their food from dead or living organisms. If they get it from dead organisms they are said to be **saprophytes;** if from living organisms they are termed **parasites.** The plant on which the parasite lives is called the **host.** Many of the fungi are parasitic during the active growing season of the host tree but overwinter as saprophytes on dead leaves, twigs, bark, or wood. The activities of parasites in obtaining food from host plants cause diseases. Fungus and bacterial parasites are spread to new hosts by the transfer and establishment of single cells, by spores of several types, and by mycelium. Wind, splashing rain, soil water, insects, man, and other animals act as agencies of spread. After a parasitic organism has come in contact with a host plant, conditions must be favorable to its growth and development before disease can develop. One of the most important of the favorable conditions required by fungi is an abundance of moisture.

Viruses are extremely minute infectious bodies, much smaller than the bacteria, and are not visible under the compound microscope. They are transmitted by insects and other carriers and by grafting. They invade and increase in their host plants. Although we recognize the seriousness of the diseases that viruses cause, we know little regarding their exact nature.

Adverse growing conditions.—Only a few diseases caused by unfavorable growing conditions are here discussed. More complete information is given in other Farmers' Bulletins—No. 1826, Care of Ornamental Trees and Shrubs; No. 1896, Care of Damaged Shade Trees; and No. 1976, Reducing Damage to Trees from Construction Work.

COMMON TYPES OF DISEASES

The common types of parasitic diseases that are of special interest to those concerned with the maintenance of shade trees are leaf diseases, wilts, cankers, wood rots, and root rots.

LEAF DISEASES

Leaf diseases generally produce evident spotting or discoloration of foliage, and some cause leaves to fall prematurely, leaving the trees bare in midseason. Trees of species that cannot withstand repeated premature defoliation (loss of leaves) are sometimes killed by leaf diseases. In other cases repeated destruction of foliage may so lower the vigor of the tree as to make it more subject to other disorders. In general, leaf spots are probably less important from the standpoint of the life of shade trees than other types of diseases. Many leaf diseases may be considered as nuisance disorders that attack occasionally without doing much damage other than marring the appearance of the trees affected.

One common type of leaf disorder causing early leaf fall is called leaf scorch. All factors involved in the development of leaf scorch are not well understood. It can arise from failure of the roots to supply under some conditions sufficient water to the leaves. The disease often

develops when high temperatures, brilliant sunshine, and drying winds follow several days of rainy weather. Root injuries, poor soil, and drought may also be responsible for leaf scorch. In treating trees affected with leaf scorch, prune the tops and improve the soil.

A number of leaf diseases that occasionally damage shade trees are caused by parasitic fungi and bacteria. To control them it is necessary to use protective measures that are preventive rather than curative. The simple treatments recommended for leaf diseases will be most effective if applied before the disease becomes established. Such treatments ordinarily will not kill parasites that are growing within the leaf tissue.

Control of leaf diseases is accomplished largely by applications of fungicidal sprays or dusts. These are usually most effective when used early in the season. In many cases where the fungus also attacks the wood, pruning is helpful. Although not always beneficial, burning badly diseased fallen foliage is sometimes advisable.

WILTS

A number of fungi are able to invade the wood vessels through which the water and food-building materials of the tree are transported. In vascular diseases (those affecting the sap system), these vessels become plugged with fungus mycelium, wound gums, and tyloses (small bladderlike swellings of the cell walls). As a result, the movement of liquids through the vessels is stopped or slowed down. The fungi may produce toxins that are injurious to the host. Probably both the toxins and the restriction of the flow of water play a part in causing rapid wilting of the foliage of infected branches. Wilting is one of the symptoms of the vascular diseases. Cutting into infected parts to the sapwood often shows discolored streaks—a valuable aid in diagnosing the cause of wilting. Dutch elm disease and maple wilt are typical examples.

Some trees die from vascular diseases quickly, but others may withstand attacks for years. External symptoms may vary from year to year in their apparent degree of severity on the same tree, depending upon weather conditions, or they may become progressively more marked until the tree dies.

Control involves the use of fertilizers, the removal and burning of diseased parts where mild cases of infection occur, or the removal and burning of the entire tree if it is seriously diseased. Tools used in performing this work should be sterilized. Keeping the tree vigorous is important in combating some vascular diseases.

CANKERS

Numerous species of fungi and a few species of bacteria cause cankers of the trunks, branches, and twigs of shade trees. They produce definitely marked dead areas, especially in the bark, and slow the normal healing of wounds. If a canker girdles the stem, the part above the girdle dies.

Treatment of cankers generally consists of pruning the infected parts or cutting out diseased areas from large branches and trunks and then protecting the injury with a wound paint. Sterilize all tools used before working on other trees. To prevent cankers, avoid wounding and dress any wounds that may occur.

WOOD ROTS

Certain species of fungi cause wood rots of both living and dead trees. Most of these fungi produce fruiting bodies of the bracket or the familiar mushroom type. The great damage caused by these fungi is often done slowly. In the care of trees that we wish to keep for a long time wood rots deserve careful consideration.

Infection of living trees by wood rot fungi is probably almost entirely through unprotected wounds. Prompt treatment of wounds is much more practical than treatment of decay following the establishment of injurious fungi.

ROOT ROTS

Root diseases may lower the vigor of affected trees, make them more subject to windthrow, or cause their death. These disorders are often difficult to diagnose because the symptoms frequently are similar to those of wilt and dieback due to other causes, and because the roots are hidden from view.

A number of fungi cause root injuries. *Armillaria mellea*, the most common of these fungi, produces the familiar shoestring root rot. This fungus attacks many species of trees, but usually those that have been injured previously. Vascular diseases also may affect the roots as well as the parts above the ground. One of the bacteria, *Agrobacterium tumefaciens*, causes, on roots and other parts, conspicuous tumors that are known as crown gall.

Avoidance of wounding, sterilizing cutting tools, and dressing injured roots are advisable in the control of root diseases. Prevent undue soil compaction and provide good drainage. In removing trees affected by root disease, take up and burn as much of the root as possible. Avoid, where practical, the replanting of infected soil with trees that are susceptible to the disease.

CONTROL METHODS

Spraying, fertilizing, sanitation, pruning, and the use of immune or resistant trees are common methods of disease control.

These methods are chiefly designed to prevent parasitic fungi from becoming established, or if already established, to hinder as much as possible their spread to other trees or other parts of the same tree. This means that careful watch should be kept on important plantings, particularly early in spring, when new growth is developing, in order to give special treatment in advance of the principal wave of infection.

Some of these methods at times cure as well as prevent the spread of disease. The fertilization of the soil surrounding the roots of injured trees may enable them to overcome such diseases as canker, dieback, or wilt caused by weak parasites. The removal of diseased parts by pruning or surgery is in some cases curative.

SPRAYING AND DUSTING

One way to guard shade trees against infection by leaf diseases is to keep the leaves coated during critical periods of fungus spread with chemicals that are not highly injurious to foliage but are sufficiently toxic to fungus spores to prevent or hinder their establishment. Criti-

cal periods occur during wet weather, especially during protracted wet periods in spring. A frequently used schedule calls for three applications timed as follows: (1) Just as the buds break open, (2) when the unfolding leaves are very small, and (3) when the leaves are about half developed. If wet weather, which is unusually favorable for fungus spread, follows, further applications repeated at intervals of about 10 days may be necessary. If dry weather prevails in spring, however, a single application may be enough to control some diseases.

The materials used to protect foliage against fungi are called fungicides. They can be dissolved or suspended in water and applied as a spray, or they can be used as dry finely ground powder, which is put on as a dust.

For shade trees, dusting is less effective than spraying. The height of the trees makes it difficult to obtain an adequate coating of dust on the leaves in the tree tops and at the same time to prevent loss of the fungicide through wind drift. In spraying, drift also occurs but less extensively and the fungicide is usually more evenly distributed on the foliage.

In applying fungicides, cover both surfaces of the leaves with a fine even coating. Make the heaviest application in the top of the tree in order to allow for downward redistribution during rain.

Only a narrow margin of safety exists between applications that will control the fungi and those that will injure the tree. Relatively few materials are known to be good general fungicides suitable to protect numerous species of trees against destructive fungi.

Bordeaux mixture, which is a combination of copper sulfate and lime, is ordinarily effective against leaf spots. It is available commercially in a dry form that is ready for use when mixed with water. If the commercial bordeaux powder is used, mix it according to the directions printed on the container.

These generally call for 16 pounds of the material to 100 gallons of water. Apply only freshly mixed material. The spray can be made at home with a finely ground copper sulfate and a high grade of hydrated lime. Dissolve the copper sulfate in half the required water and mix the hydrated lime thoroughly in the remaining half. Then pour the two materials into the sprayer at the same time.

Use 8 pounds of copper sulfate and 8 pounds of hydrated lime for each 100 gallons of spray. This makes the standard 4–4–50 bordeaux mixture. In many cases it will be necessary to add something to the spray to make it spread and stick on glossy foliage. Resins, oils, soaps, and casein are examples of such sticking agents. Two pounds of calcium caseinate for each 100 gallons of spray is commonly used.

Bordeaux mixture may cause stomach disturbances if taken internally; dispose of all unused material. Clean or destroy all vessels, bags, or other containers used. If extensive dusting operations are necessary, it is well to use an approved dust respirator and goggles. Thoroughly wash clothing worn during extensive operations as soon as possible after the work is finished.

Fixed or insoluble coppers sold as proprietary compounds under trade names have come into limited use as shade-tree fungicides during the past several years. The writers have observed both good control and serious burning as a result of applications of these materials in the commercial shade tree field.

Lime-sulfur solution is not to be recommended for use as a general shade tree fungicide. It is believed at times to be somewhat damaging to the foliage; its odor is objectionable near residences, playgrounds, and highways; and it is destructive to painted surfaces exposed to drifting spray.

A number of very finely divided sulfurs are available under various trade names. If used, they should be applied in accordance with the manufacturers' instructions.

SANITATION AND PRUNING

The removal and destruction of diseased leaves and twigs reduces the quantity of spore-bearing material from which infection can occur. In many cases it is doubtful whether the fallen leaves of trees seriously infected with leaf diseases should be burned. The degree of control thus achieved has not been proved. Wholesale destruction of leaves rather than their return to the soil as litter or as compost may in the end cause more injury than that done by the disease organisms. Sanitation, pruning, and removing hopelessly diseased trees are better methods of disease control.

Carefully carried out, pruning removes much cankered and diseased wood. Their removal will prevent spread of the infection from diseased to healthy parts, improve the appearance of the affected tree, and prevent spread of the parasite from diseased to nearby healthy trees. Timely pruning of weakened parts that are not infected may prevent a disease from becoming established on a valuable tree. In some cases cankers can be removed by cutting out infected tissue, but pruning off the diseased parts is the more common practice. Prompt burning of material removed destroys a large part of the potential disease source for the next growing season.

In performing such work a safe precautionary measure is to sterilize cuts and cutting implements. Denatured alcohol can be used for this purpose. Surfaces or tools to be sterilized can be swabbed, dipped, or thoroughly sprayed.

WOUND TREATMENT

Wound treatment is advised for badly bruised, cut, or splintered tissue and for areas from which diseased tissue has been removed. After the injured or diseased wood and bark are cut out, the surface of the wound should be smoothed and the margin shaped.

The shape of the wound has a marked effect on the rate at which healing can take place. Other things being equal, smooth, regular wounds heal more quickly than those that may be rough or irregular. Bark areas cut off from the natural lines of sap flow heal more slowly, or not at all, depending largely on how far they are from sap lines. When removing branches, make the cuts flush, or even, with the trunk or larger branch, in order to leave no protruding stub that would interfere with rapid healing.

On trunks the bark at the margin of large wounds should be cut to a more or less elliptical (egg-shape) form, with pointed ends. The long axis should run lengthwise of the trunk. In shaping the pointed ends the removal of some healthy bark is generally necessary (fig. 1). Healing proceeds more rapidly, however, if wounds are cut to this general form. The margin of the wound should be even, smoothly

edged, and have no projecting, torn, or bruised bark extending into the central wound area. In treating injuries that reach or extend below the ground line the wound may be pointed at the top only but less regularly shaped at the base.

In general, pruning cuts and other injuries should be treated with a wound dressing as soon as possible to keep out infection and promote healing. Such treatment is more important for large wounds than for small ones that will heal in one or two growing seasons. It is probably less important for some conifers that coat their wounds with a resinous exudate than for other trees. A wide variety of materials is used for this purpose.

FIGURE 1.—The dotted line indicates the proper shaping for an irregular wound. The bark within the dotted line should be removed.

Wound dressings having an asphalt base are among the more popular kinds. Both water emulsions and asphalt diluted with various solvents are used—asphalt in solution for general work and the water-emulsion type for application to wet wood. Generally speaking, the asphalt type of dressing to which no cresote has been added allows the cut to produce an excellent callus. On the other hand, asphalt, used either alone or mixed with creosote and applied to wounds that are not sterilized before being dressed, often fails to prevent infection. Applied in very thick coatings, asphalt not only frequently blisters but also appears in many cases to stimulate decay rather than to retard it.

Bordeaux paint as developed at the Oregon Agricultural Experiment Station is outstanding in its ability to guard wounds from infection and decay, although it will not penetrate bark or wood and destroy fungus mycelium that is already established. The dressing is somewhat permeable and for that reason does not blister or interfere with the natural deposition of wound gums or width tyloses (bulging ingrowths that close the vessel cavities). On the other hand, bordeaux paint has marked disadvantages. It is more expensive than most other wound dressings. It will not adhere to wet wood. The callus growth under it is slightly less than that obtained with some of the less permeable dressings. Several investigators have reported an enlargement of wounds following its use. Only freshly mixed paint can be used. It has an objectionable blue or green color.

Bordeaux paint is made by stirring together raw linseed oil and commercial bordeaux powder to form a thick paint. The bordeaux

powder should be fresh and the paint used promptly after it has been mixed. In combining materials, a heavy rather than a thin mixture is desirable. When first stirred together, the mixture should be very stiff. After letting it stand a short time, stir it again to produce a heavy, creamlike mixture. If the paint becomes thin on being stirred the second time, thicken it by adding more bordeaux powder. The excess oil in thinly mixed bordeaux paint is harmful to the development of healthy callus growth. The paint should be applied heavily to the cut surface with a swab or a short-bristled brush.

This wound dressing is poisonous if taken internally. Consequently, keep both the material and the uncleaned brushes or containers out of reach of children or domestic animals. Clean the vessels containing this and other poisonous preparations immediately after using, and dispose of any remaining poison.

Spar varnish is sometimes used for dressing wounds. It has the advantage of being fairly lasting and of not seriously interfering with callus formation, especially if applied over a coat of shellac. It is not an antiseptic.

Shellac, lanolin, rubber latex, melted beeswax or paraffin, and numerous forms of grafting waxes are valuable for treating small wounds. They are also useful for ringing large wounds that are to be treated with a sterilizing agent or a wound dressing that would otherwise be injurious to the *cambium* (growing cells from which bark and wood are formed).

Apply antiseptic washes and wound dressings as promptly as possible after injury occurs. Even a brief delay may permit the entrance of infectious organisms. Regardless of the type of dressing used, examine wounds 2 inches or more in diameter within 6 to 12 months after completing the work, in order to detect possible defects and make necessary repairs. Reexaminations are often necessary to detect imperfections that develop later. Under certain conditions the dressings tend to open with the splitting of the wood, or they may blister, peel, or weather away. If they are found to be defective, repair the dressings at once after scraping off any loose or blistered material.

Further information is given in Farmers' Bulletin No. 1896, Care of Damaged Shade Trees.

FERTILIZING

Maintenance of normally vigorous growth is important in combating many tree diseases, particularly those caused by weak parasites. It is also highly important in promoting the rapid callusing and healing of pruning cuts and other wounds. To assure normal growth, the soil must contain an adequate supply of food-building ingredients. These must be available to the tree along with a water supply suitable for the best development of the particular tree.

The natural cover of loose duff, similar to that found on the forest floor, is seldom allowed to remain under shade trees. Keeping the ground raked clean prevents the return to the soil of mineral elements and humus released by decaying litter. The soil becomes hard and poor and no longer supports vigorous tree growth. In time, trees growing on such soil tend to show symptoms of low vitality, such as

lack of normal green color, stunted annual twig growth, undersized buds and leaves, sparse foliage, and many dead twigs and branches.

To prevent or remedy such starvation, fertilizing ingredients can be supplied. They are usually put in holes under the tree, but not so close to the trunk as to cause mechanical or fertilizer injury to the roots. For large trees make an inner circle of holes 6 or 8 feet away from the base; for small ones dig the holes closer. Have the outer circle extend somewhat beyond the drip of the branches. Space the holes about 2 feet apart within the area bounded by these two circles. A commonly recommended depth for these holes is 18 inches. If a fertilizer likely to injure sod is used, pour it into the openings through a funnel to within a few inches of the surface of the ground and plug the remaining opening by stamping with the heel or by filling with bonemeal, loam, or compost.

The dosage and material must necessarily vary widely, according to the degree to which the soil is depleted and to the requirements of the particular tree. The quantity to be applied to any given deciduous tree is usually 2 pounds of high-grade complete fertilizer for each inch in circumference the trunk measures at breast height. Less fertilizer is generally needed for evergreens.

Spring and fall are considered especially good seasons for fertilizing. Many shade trees benefit from annual applications, but care should be taken to avoid overstimulation, which, by producing soft lush growth, may increase susceptibility to disease.

For a more detailed discussion of fertilizing and other procedure on the maintenance of normal vigor, see Farmers' Bulletin No. 1826, Care of Ornamental Trees and Shrubs.

RESISTANT OR IMMUNE TREES

Species and varieties of shade trees differ in the degree to which they may be affected by any particular disease. For example, not all species of elms are equally susceptible to Dutch elm disease—the Siberian being resistant and the American susceptible. Furthermore, individual Siberian elms differ in degree of susceptibility. The degree to which they are resistant to one disease is not necessarily related to their resistance to others.

In the selection of trees for shade and ornamental purposes avoid as far as possible those that are known to present unusually difficult problems of disease control. Frequently the replacement of seriously affected trees by those more resistant is the logical disease-control program. Plant breeders are aiding in this valuable form of control by discovering and developing varieties of trees resistant to disease.

DISEASES OF SPECIFIC TREES—CAUSES AND CONTROL

Trees are arranged alphabetically according to their common names.

AILANTHUS

Wilt

Wilt sometimes attacks young ailanthus (tree-of-heaven) trees and results in serious injury. The causal fungus is a species of *Verticillium*. The symptoms of the disease are similar to those associated with

verticillium wilt in elm and maple. The leaves turn yellow and fall early in the season, and the branches die slowly. Brownish discoloration or streaks in the wood are present in diseased branches.

If only a few branches are attacked, prune them out by cutting well below the discolored areas. Remove and burn severely diseased trees. For information on sanitation and pruning, see page 6.

ARBORVITAE

Winter Injury

Late in winter or early in spring, arborvitae, junipers, pines, and other evergreens sometimes show extensive browning and dying of the foliage of the previous season's growth. This is caused by the rapid loss of water from foliage exposed to warm sun or drying winds when the ground is still frozen and by the roots not being able to take in a supply of water sufficient to counteract the loss. Trees with a shallow root system and those in places exposed to the prevailing winds are most commonly affected. The use of a mulch prevents deep freezing in cold weather and helps to conserve soil moisture during dry periods.

Winter injury should not be confused with the browning of evergreen foliage which occurs late in fall and is confined to old, mature needles—those nearest the tree trunk. This browning and leaf fall is a natural occurrence in all evergreens, but is particularly conspicuous in arborvitae and pines.

ASH

Anthracnose

Anthracnose, caused by the fungus *Gloeosporium aridum*, only occasionally produces marked injury to ash. Large light-brown spots develop on affected leaves and premature defoliation may occur. Following unusually wet springs the disease sometimes becomes locally prominent.

Only in exceptional cases is control recommended. Two applications of bordeaux spray are advised—one just before the buds open and a second just after they break. Burning diseased leaves as they fall is advisable. For information on spraying and sanitation, see pages 4 and 6.

Leaf Scorch

Leaf scorch is a browning of leaves throughout the top or on the windward side of the tree. See Maple, page 28.

Rust

Ash rust is caused by the rust fungus, *Puccinia peridermiospora.* The white, black, green, red, and a number of other ashes are subject to the disease. Early in the growing season the leaf blades, petioles (leafstalks), and twigs of these trees are frequently attacked by the rust, which produces conspicuous swellings (fig. 2). In these swellings small fungus cups with toothed edges produce orange-colored powdery masses of spores. These spores do not infect ash but produce the disease on marsh and cord grasses, which are called alternate hosts of the rust. Spores produced by the rust on these grasses infect ash the following spring. Little damage is caused by this disease. Control measures are usually not necessary.

FIGURE 2.—Ash rust has caused the swelling of the petiole. Natural size.

White Mottled Rot

White mottled rot of the heartwood of ash is caused by the fungus *Fomes fraxinophilus*. This fungus also occurs on dead trees. The fruiting bodies, sometimes called conks, are shelflike and large. Older conks are usually cracked and are velvety and straw-colored on the under side and have large circular pores (fig. 3). Being hard and woody, conks persist on the tree from year to year. In early stages of decay produced by this fungus the wood develops a brown discoloration containing white spots, and, in an advanced stage, straw-colored areas intermixed with white.

The fungus usually enters the tree through dead branch stubs or unprotected pruning wounds; therefore all open wounds should be dressed. In pruning trees on which conks occur, take extra care to

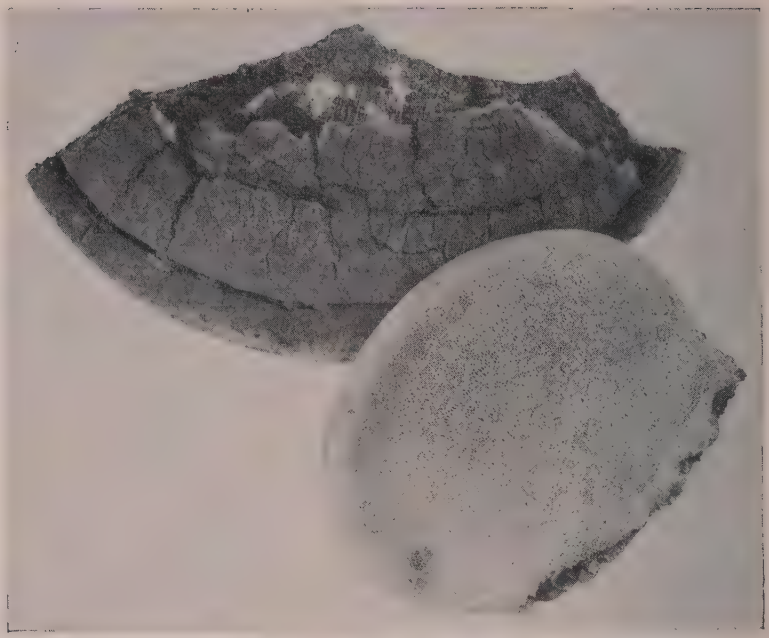

FIGURE 3.—Upper surface (above) and lower surface (below) of fruiting bodies of the ash wood-rotting fungus. One-half natural size.

sterilize tools and pruning cuts in order to prevent the spread of the fungus. For information on pruning and the sterilization of pruning tools, see page 6.

ASPEN

See Poplar, page 43.

BASSWOOD

See Linden, page 26.

BEECH

Injury From Changes of Environment

The beech is especially subject to injury from soil compaction, grading, or drying due to sudden removal of surrounding trees. Avoid subjecting this tree to any sudden changes of environment.

Leaf Scorch

Leaves of beech are browned from the margin inward. See Maple, page 28.

BIRCH

Nectria Canker

Many hardwoods, especially birch, are affected by *Nectria galligena*, which deforms shade trees and produces the most common and serious canker disease of eastern hardwood stands (fig. 4). The fungus

deforms the trunks and frequently kills trees. Cankers produced by it are sunken, about as wide as long, with targetlike concentric rings. The fruiting bodies of the fungus are small, round, red, dotlike pustules, usually in small groups. They are not always present on the cankers.

Proper sanitation calls for the removal and burning of infected material as far as is feasible. To guard against further spread of infection, prevent as far as possible all open wounds. Sterilize tools used for cutting infected wood. For information on pruning and sterilization of pruning wounds see page 6.

FIGURE 4.—Birch canker. One-half natural size.

White Trunk Rot

White trunk rot, caused by the false tinder fungus (*Fomes igniarius*), seriously affects many kinds of hardwoods (fig. 5). The birch is commonly subject to it. Decay is usually confined to heartwood, but in the yellow birch the living sapwood also is attacked. The wood becomes light in weight, soft, and whitish. In later stages fine black lines are present. The fruiting bodies, or conks, are grayish to black more or less triangular to hoof-shaped brackets that become rough and cracked with age. The undersurface is brown and shows small pores.

Protection of wounds, as described on page 6, should assist in controlling the spread of this fungus to healthy trees.

BLACK LOCUST

Brooming Disease

Although the brooming disease of black locust has been known for many years, it has only recently been considered a virus disease. It has been found in an area from southern Pennsylvania and Ohio southwest to Arkansas and east to Tennessee and North Carolina. The most conspicuous symptom is the abnormal development of buds into short branches having leaflets smaller than normal. The buds on these short branches develop in the same way, until there is a pro-

fusion of branches or a broomlike growth. This abnormal growth usually occurs late in summer and frequently dies during the following winter. The disease is most common on young sprouts after pruning or the cutting back of the roots and may often be seen along highway and railroad banks. Diseased trees frequently recover, but sometimes all or a part of the tree dies.

No method of effective control is known as yet, and severely diseased trees should be removed and destroyed.

FIGURE 5.—False tinder fungus fruiting on hophornbeam. One-twelfth natural size.

BOXELDER

See Maple, page 27.

BUCKEYE

See Horsechestnut, page 24.

BUTTONBALL

See Sycamore, page 48.

CEDAR

See Redcedar, page 45.

COTTONWOOD

See Poplar, page 43.

DOGWOOD

Crown Canker

Flowering dogwood in ornamental plantings is sometimes attacked by crown canker, caused by *Phytophthora cactorum*. It is known to occur in New York, New Jersey, and Massachusetts. The appearance of small light-green leaves and the death of twigs or branches, particularly on one side of the tree, are the first visible symptoms. Later the bark on the trunk just above the ground level becomes dry and falls off, exposing discolored wood. When this canker girdles the trunk the entire tree dies. The fungus causing the canker lives in the soil and has been found in basal cankers on maple and beech.

No method of control has proved effective, but the prevention of trunk wounds or their treatment, as described on page 6, is advisable. Avoid undue wetness about the root crown. Destroy infected trees, including roots.

DOUGLAS-FIR

Gray Mold Twig Blight

Gray mold twig blight, caused by *Botrytis cinerea*, frequently kills the ends of shoots of Douglas-fir during wet springs. True firs,

larches, and other conifers are sometimes affected. The tip of the young growth becomes a cluster of dead, curled leaves, resembling frost injury. Under wet conditions abundant cobwebs of gray mycelium-bearing spores cover diseased tips. Small black bodies, called *sclerotia*, carry the fungus through unfavorable growing conditions. The disease does not progress after the leaves mature.

Treatment calls for improved air circulation by careful thinning.

Needle Blight

Needle blight is caused by the fungus *Rhabdocline pseudotsugae*. Douglas-fir is the only kind of tree affected: the true firs (species of *Abies*) are not susceptible. The disease is common on Douglas-fir in its native range—the Pacific Coast and Rocky Mountain States—and occurs also on ornamental Douglas-firs in the Northeastern States. Needles become infected in spring or early in summer, and the first symptoms of disease become visible in fall or early in winter. The following spring reddish-brown spots appear, usually near the tips of the needles. Gradually the discoloration spreads until, in cases of severe infection, entire needles become brown and fall off. By fall an infected tree may bear only needles of the current season's growth. The damage is most severe on young trees, particularly if infection is heavy for several successive seasons.

To control the disease, spray with a 4–4–50 bordeaux mixture early in spring as soon as the new leaves develop. Follow this with two additional applications at intervals of 10 days or 2 weeks. For information on spraying see page 4.

Needle Cast

Needle cast of Douglas-fir, caused by *Adelopus gäumanni*, injures these trees in the New England States and New York. The causal fungus occurs in western North America on Douglas-fir in many parts of its natural range but is known to cause injury in but few places. On severely affected trees in the Eastern States the infected needles fall prematurely. In some cases only the needles of the current season's growth remain on the trees (fig. 6, *A*). The disease resembles needle blight caused by *Rhabdocline pseudotsugae;* in fact, both may occur on the same tree. The fungus of needle cast forms small black fruiting structures on the lower surface of the needles, clearly visible only through a magnifying glass (fig. 6, *B*). These black bodies are present on both green and brown needles, in rows on each side of the middle vein, and are the identifying signs of the disease. The extent of the damage caused by this disease is not yet known, and experiments on control are still being conducted.

Applications of spray as recommended for needle blight (above) are suggested for controlling needle cast.

ELM

Black Mold

See Linden, page 26.

Black Spot

Black spot of the elm is caused by the fungus *Gnomonia ulmea*. During wet seasons this leaf spot sometimes causes a premature drop of foliage. The fallen leaves are usually yellow and show small but

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FIGURE 6.—*A*, On this Douglas-fir, needle cast has caused the loss of most of the needles except those of the current season. One-twentieth natural size. *B*, Small black fruiting structures of the causal fungus on the lower surface of an infected needle. Eight times natural size.

conspicuous, shining, coal-black spots (fig. 7). Its damage to American elm is occasionally severe, and it seriously defoliates the Siberian elm.

Trees can be protected by treatment applied in advance of the principal infection period. Standard 4–4–50 bordeaux mixture or sprays or dusts of finely divided sulfur are effective. Three applications of the selected material are necessary—the first when the leaves are unfolding, the second when they are full-sized, and the third about 2 weeks later. The raking and burning of heavily infected leaves are also recommended. For information on spraying and dusting see page 4.

Brown Wood Rot

A very common brown wood rot that may involve both heartwood and sapwood of living elms is caused by the fungus *Pleurotus ulmarius*. The decayed wood is easily separated along the annual rings. The fruiting bodies of this fungus are large white to buff-colored fleshy annual mushrooms with broad white gills. They are produced on stems 2 to 4 inches long.

Proper dressing of wounds, including split crotches, is advocated to prevent infection of healthy wood. See page 6 for directions for treatment of wounds.

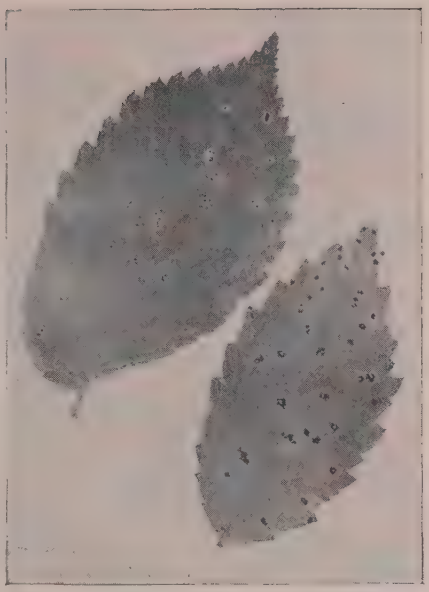

FIGURE 7.—Black spot, a fungus disease of elm, causes the leaves to fall prematurely. One-half natural size.

Dieback

Dieback of elm, also referred to as cephalosporium wilt, is caused by the fungus *Dothiorella ulmi*. This dieback has been found only on American and slippery elms. It is common throughout the Eastern States. The symptoms are so much like those of wilt and Dutch elm diseases that in most cases cultures are necessary for accurate diagnosis. The fungus infects leaves and young twigs, gradually spreading downward through the wood of the branches and trunk, sometimes into the roots. Wilting and dieback, and occasionally the death of entire trees, result.

Trees not too severely affected are often benefited by pruning out the diseased wood and using fertilizer. For information on pruning and fertilizing, see pages 6 and 8.

Dutch Elm Disease

All species and varieties of elm native to North America are susceptible to the Dutch elm disease, which is caused by the fungus *Ceratostomella ulmi*. The disease, particularly on American elm, is prevalent in New York, Pennsylvania, New Jersey, Connecticut, and western Massachusetts. It occurs also in a few places in Vermont, Maryland, Virginia, West Virginia, Kentucky, Ohio, and Indiana. The leaves of infected trees wilt and become dry, sometimes so suddenly that they fall while still green. Usually the wilting takes place more gradually, beginning on single branches and slowly spreading over the entire tree (fig. 8). The presence of the causal fungus is indicated by the browning of the water-conducting tissue of the wood. Brown streaks or spots may be scattered through the wood or may form a broken circle, as seen in a cross section of a branch. Since other elm diseases have similar symptoms, laboratory cultural tests are necessary for an exact diagnosis. Send samples and a complete report, including

FIGURE 8.—Dutch elm disease has caused leaves on several of the branches of this tree to wilt.

the exact location of the tree, to your State agricultural college or to the Bureau of Entomology and Plant Quarantine, United States Department of Agriculture, Brick Church Station, East Orange, N. J.

The disease is spread by elm bark beetles which carry the fungus from infected trees to their feeding and breeding places on other elms or on fallen or cut elm wood. Infection also occurs through natural root grafts between infected and uninfected trees. Getting rid of the bark beetles is the most effective control measure. All wood infested with the beetles should be burned or treated with an effective spray. The following are suggested in United States Department of Agriculture Circular 677, Dutch Elm Disease and Its Control: Fuel oil (26° to 28° Baumé), 12 parts by volume, and monochloronaphthalene, 1 part; or fuel oil, 4 parts, and orthodichlorobenzene, 1 part. Spray when the insects are most active, usually at the time apple trees flower or when elm leaf buds open and form young shoots. The spray may be used in summer as a repellent on freshly cut elm wood. Pruning all branches infected by bark beetles is also an important control measure. Do not store elm wood in the open unless the bark is removed or the wood sprayed as suggested. Additional details concerning the disease and its control are given in the circular mentioned.

Monochloronaphthalene and orthodichlorobenzene contain poisonous and flammable substances. Mix and use them outdoors.

Nectria Canker

Trees suffering from drought, winter injury, or suppression are frequently attacked by the fungus *Nectria cinnabarina*. Many species are affected, among them the elm. The fungus occurs on small dead branches and twigs, but at times it becomes sufficiently parasitic to damage living tissue and to form small cankers on the twigs. Reddish fruiting bodies are produced in great abundance.

A similar fungus, *Nectria galligena*, discussed under birch, causes conspicuous cankers on trunks and large branches. Its fruiting bodies

are similar to those just described but tend to be produced less frequently and in less abundance.

Removing and burning wood infected with nectria canker, avoiding all unnecessary wounding, and promptly dressing wounds are safeguards against a spread of the infection. For information on pruning and wound treatments, see page 6.

Phloem Necrosis

American elms from West Virginia to Kansas and south to Mississippi have been attacked by phloem necrosis. The causative virus is highly infectious and in some areas 50 to 75 percent of the American elms have been killed in 5 years. Affected trees show a drooping and curling of the leaves, which become yellow, then brown, and then fall off. The most definite and characteristic symptom of the disease is the brownish discoloration of the inner bark, or phloem, of affected roots and trunk and sometimes of the branches. In early stages of the disease the discolored inner bark has a faint odor of wintergreen, which is a means of identification. The methods by which the virus is spread are not known. Control measures are under investigation, but no effective cure is known. Trees other than the susceptible American elm should be used in affected areas. Further details concerning this disease are given in United States Department of Agriculture Circular 640, Phloem Necrosis, a Virus Disease of the American Elm.

Slime Flux and Wetwood

Sap often flows for a prolonged period from pruning cuts, broken crotches, and other injuries, especially in spring or during wet weather. Sometimes this is caused by wetwood, a tree disease. The exuding fluid commonly becomes contaminated with various organisms, as bacteria, fungi, and nematodes, and is converted by them into a thick, malodorous, variously colored slime. This slime interferes with or prevents the

FIGURE 9.—Slime flux of elm.

healing of the wound and tends to kill back any healthy bark over which it flows. Trees commonly affected are elm, maple, birch, oak, horsechesnut, linden, poplar, and sycamore.

Slime flux of elm is caused by a species of bacterium, *Erwinia nimipressuralis*, which infects the wood of the tree and causes an increase in its internal pressure. This pressure forces fluids out of the trunk and branches at weak places, such as pruning cuts and wounds (fig. 9). Some of the products of the bacteria are toxic to the tree and slow its growth.

The cause of slime flux of elm was determined only recently, and investigations have not yet been extended to other species, but the cause may be similar in them.

Although no treatment for this disease is known, the condition and appearance of the affected tree can often be improved by installing in the infected parts of the trunk tubes to drain off the excess fluids and relieve the pressure. Sometimes several tubes will be necessary, but often a single one near the base of the trunk is sufficient. In making an installation first determine whether the infected wood extends to the base of the trunk. This can be done by boring a 3/8-inch hole near the base and directly under the part that is fluxing. The hole should slope slightly upward and reach the center of the trunk.

If waterlogged tissue is tapped, the sour sap may be discharged under pressure. If infected wood is not located by the first drilling, additional holes should be bored higher on the trunk and closer to the fluxing wounds. When the pocket is located, a piece of galvanized pipe having a driving fit should be forced 2 to 3 inches into the auger hole. The pipe should be long enough to carry the drip free of the trunk and root crown. If the pressure can be relieved it is sometimes possible to dry up and dress the wounds, but many cases of slime flux will not respond to this treatment.

The drying-up and healing of fluxing areas is often hastened by cleaning and sterilizing the wounds frequently with an antiseptic wash. A 1 to 1,000 solution of mercuric chloride may be used for this. Tablets sold by drug stores are convenient for making the solution. If the mercuric chloride is not obtainable, denatured alcohol may be substituted, but it is less effective.

Mercuric chloride is a corrosive and deadly poisonous chemical. Do not permit the antiseptic to flow over onto the live bark, and do not leave any unused solution within the reach of children or animals.

Typical slime flux should not be confused with the bleeding cankers of maples and some other hardwoods, described on page 27.

Sphaeropsis Canker

The fungus *Sphaeropsis ulmicola* causes dieback and canker of the twigs and branches of American elm. The disease gradually spreads downward from the small twigs into the larger branches. A brown discoloration of the wood just below the bark of the infected areas indicates the presence of the fungus. Rapidly growing secondary shoots sometimes develop below the cankers. Trees weakened by drought or poor growing condition seem to be particularly susceptible.

Treatment includes improving the vigor of the trees by fertilizing and pruning out infected wood, cutting well below the cankers. For information on sanitation and pruning and on fertilization see pages 6 and 8.

Ustulina Butt Rot

The fungus *Ustulina vulgaris* causes ustulina butt rot in numerous trees, including red and sugar maples, elm, black and red oaks, paper birch, planetree, beech, and ash. The disease is common on these trees in forest stands throughout the Eastern States and causes severe injury to elms, lindens, and maples used as shade trees.

It forms inconspicuous flattened cankers at the base of the tree where irregular brown or black crusty masses of fruiting bodies are produced, either just under loosened bark or on exposed surfaces. At times the fruiting bodies produce an abundance of grayish powder composed of millions of spores by which infection is spread to other trees.

The fungus produces a brittle white rot that shows prominent black zones extending through and around the region of decay. Both heartwood and sapwood are attacked. Usually most of the decay is at the ground line (fig. 10). For this reason trees having ustulina butt rot are frequently windthrown. Street trees in advanced stages of the disease may damage property and endanger the life of the passer-by.

Prevention of wounding and prompt treatment of wounds of susceptible trees will control the spread of the disease. See page 6 for information on wound treatment.

White Flaky Rot

White flaky rot of heartwood and sapwood is caused by the oyster mushroom (*Pleurotus ostreatus*). The cap of the fungus resembles that of *Pleurotus ulmarius*, described under brown wood rot. The

FIGURE 10.—*A*, Ustulina butt rot has made this large elm susceptible to windthrow. One-twelfth natural size. *B*, Closer view of the causal fungus fruiting just above the ground line at left of cavity. One-half natural size.

FIGURE 11.—Oyster mushroom fruiting on living yellow-poplar. One-half natural size.

oyster mushroom, however, either has no stem at all or only a very short one. The fruiting bodies usually grow in crowded clusters (fig. 11).

Proper dressing of wounds is suggested to prevent the spread of the fungus. See page 6 for directions for wound treatment.

Wilt

Wilt is caused by a species of the fungus *Verticillium*. The disease is common on elms in the Eastern States. American, English, and red elms are susceptible, as also are maples and ailanthus. The wilting of leaves, early defoliation, and the death of entire branches are similar to the symptoms of the Dutch elm disease. Also the presence of brownish streaks in the wood or complete or broken rings of discoloration in cross sections of branches are typical of both diseases. For this reason an exact diagnosis requires a laboratory cultural study.

Severely infected trees should be removed, destroyed, and replaced by other kinds of resistant trees. If only a few branches are attacked, prune them out, cutting well below the infected areas. Carefully sterilize all tools used in pruning. Liberal applications of fertilizer are believed by some authorities to be helpful if applied promptly after pruning. For information on pruning and fertilizing, see pages 6 and 8.

FIR

Tip Blight

Tip blight of fir is caused by the fungus *Rehmiellopsis balsameae*. The yellowing of the leaves of the new growth and the dying back of young twigs are its most common symptoms. The disease attacks native balsam firs and ornamental white or Colorado firs in the Northeastern States. The repeated dying-back of the twigs in successive seasons results in a weakening of the trees and in the case of small trees eventual death. Infection takes place during a short period early in spring when the buds and young shoots are developing.

Effective control may be obtained by spraying with a 4–4–50 bordeaux mixture to which a spreader, such as casein, has been added. The first application should be made just as the buds are opening, fol-

lowed by two additional applications at intervals of 10 days or 2 weeks to protect later developing leaves. For information on spraying see page 4.

HAWTHORN

Cedar-Hawthorn Rust

Cedar-hawthorn rust, caused by the fungus *Gymnosporangium globosum*, frequently attacks the leaves—rarely the fruits and young stems—of hawthorn, causing orange-colored spots and a premature falling of the foliage. The disease first becomes evident early in summer. Rust spores are produced in tiny cuplike bodies that are arranged in a circle on the underside of the rust spot. These spores do not infect hawthorn; they infect redcedar, the alternate host. For a description of the disease and its control, see redcedar (p. 47). Spores produced on galls on redcedar infect the hawthorn. These spores are discharged during wet spring weather when the horns of the galls are swollen and jellylike.

Rust on the hawthorn can be avoided by not growing redcedars and hawthorns in the same vicinity or by controlling the disease on the redcedar. Where it is necessary to resort to the more difficult control on the hawthorn, three applications of bordeaux mixture or wettable sulfur are suggested. The first treatment should be applied just prior to the time when the horns on the cedar galls first gelatinize, usually late in April or early in May. The two remaining sprays should follow at 10-day intervals. See page 4 for information on spraying.

Fire Blight

Fire blight is caused by the bacterium *Erwinia amylovora*. The English hawthorn is more subject than the native species to this disease. It gets its name from the blackened and burned appearance of the affected blossoms, leaves, and twigs. Wet springs favor attacks, but their severity varies greatly from year to year.

Cut off all diseased branches several inches below the farthest visible point of infection, as shown by light to dark-brown discoloration beneath the bark. Determine the extent of all bark cankers on the trunk and larger branches and cut out the infected tissue until sound growth is reached at the margin of the canker. Tools and cuts should be carefully sterilized. Avoid overstimulation of growth caused by excessive use of nitrogenous fertilizer, as the watery tissues are especially subject to attack.

Leaf Spot

Leaf spot of hawthorn is caused by the fungus *Fabraea maculata*. The English hawthorn is frequently defoliated late in summer by this disease. The affected leaves are thickly covered with small, angular, reddish spots that first appear in spring. Later in the season numerous round black bodies containing the spores of the causal fungus can be seen in these lesions, with the aid of a magnifying glass.

To control the disease sufficiently to prevent early leaf fall, rake and burn the infected foliage. Spray the trees with three applications of bordeaux mixture. The first treatment should be applied when the buds break; the second and third should follow at intervals of 7 to 10 days, depending on weather conditions. See page 4 for information on spraying.

HICKORY

Witches'-broom

Witches'-broom on shagbark hickory is apparently caused by the same fungus, *Microstroma juglandis*, that causes a leaf spot of butternut and black walnut. The brooms are best seen during the dormant season, when the trees are bare. They are composed of compact clusters of branches that grow from a common point on the branch and have a bushlike appearance. During the growing season the leaves produced by these witches'-brooms tend to be undersized and curled. Early in the season their undersurface is mealy with spores of the fungus. During midseason the leaves blacken and fall.

Effective control measures are unknown.

HOPHORNBEAM

White Trunk Rot

See Birch, page 13.

HORSECHESTNUT

Leaf Blotch

Leaf blotch of horsechestnut and buckeye is caused by the fungus *Guignardia aesculi*, the attacks of which may result in severe, premature defoliation. Infected leaves develop large, conspicuous, reddish-brown spots that are often surrounded by a yellowish halo (fig. 12). Large areas of the leaf are frequently involved, and curling of the leaves is common. Small black fruiting bodies speck the lesions.

FIGURE 12.—Leaf blotch of horsechestnut and buckeye. Affected leaves fall prematurely. One-half natural size.

Destroy fallen leaves. To prevent defoliation apply three sprays of bordeaux mixture or of sulfur. Apply the first treatment as the leaf buds open, the second when the leaves are half grown, and the third when they are fully expanded. See page 4 for information on spraying.

JUNIPER

See Redcedar, page 45.

LARCH

Canker

Canker, also known as European larch canker, is caused by the fungus *Dasyscypha willkommii*. The fungus was introduced on dis-

FIGURE 13.—European larch canker. Small cuplike growths on the diseased area are the fruiting structures of the causal fungus. Four times natural size.

eased nursery stock from Great Britain and attacked ornamental European larches in eastern Massachusetts. Although the American larch, or tamarack, is susceptible to the fungus, it has not been found infected in this country. Japanese larch is relatively resistant, and golden larch is susceptible. The fungus produces branch or trunk cankers with depressed bark. As the cankers develop, the bark at the margin becomes cracked and resin appears. Small white to orange cuplike growths on the diseased area are the fruiting structures of the fungus (fig. 13). The disease may kill young trees or entire branches of older ones, but usually it causes only a weakening of the branches, which therefore are easily broken by snow or wind.

Careful and thorough removal of all trees showing the cankers is the only dependable method of preventing the spread of the disease. It has been controlled by this method in the few localities in New England in which it has been found, but it may appear in other places.

LINDEN

Anthracnose

Anthracnose of linden (basswood), caused by the fungus *Gnomonia tiliae*, causes irregular light-brown spots on the leaves, particularly along the veins. When the spots are numerous they merge, producing large brown blotches. Small cankers frequently form on the twigs, and in these or in fallen leaves the fungus lives over winter. In wet seasons the disease may cause early defoliation.

Control may be obtained by two or three applications of 4–4–50 bordeaux mixture in spring. For information on spraying see page 4. Sanitation pruning and the burning of fallen leaves are advisable. In most seasons, however, loss of leaves is so slight that control is not necessary.

Black Mold

A heavy black threadlike growth of *Fumago vagans* and related fungi frequently covers the leaves and mars the appearance of the linden, elm, Norway maple, tuliptree (yellow-poplar), white pine, and other trees and sometimes causes premature leaf fall (fig. 14). The fungus in this case is not a parasite but develops saprophytically in the honeydew produced by aphids and scale insects. Control of the insects will prevent this condition.

FIGURE 14.—Black mold has produced the heavy soot-like layer that covers this elm leaf. Natural size.

Leaf Spot

Leaf spot, caused by *Cercospora microsora*, is common on linden, producing small light-brown circular spots with a dark margin. Usually no serious defoliation results.

After severe attacks the fallen leaves should be burned and a 4–4–50 bordeaux spray applied in spring just as the buds are opening and again after 10 days. For information on spraying see page 4.

Ustulina Butt Rot

See Elm, page 21.

LOCUST

See Black Locust, page 13.

LONDON PLANETREE

Canker Stain

Although a disease that has not long been recognized, canker stain has proved highly destructive to the London planetree planted as street trees in the North Atlantic States. It is caused by a fungus of the genus *Endoconidiophora*. Trees attacked show sparse foliage, undersized leaves, and elongated sunken areas on trunks and larger branches. Cross sections of infected trunks show blue-black streaks that are often wedge-shaped, with the point of the wedge extending toward the center of the tree. When numerous cankers develop on a trunk it generally becomes girdled and the tree dies.

The disease can be controlled by the following measures: (1) Remove all diseased trees or parts of trees. Some having infections limited to branches may be saved by pruning. A clearance of 3 feet between the severing cut and the nearest infection is usually necessary. (2) Avoid all unnecessary mutilation of trees. (3) Disinfect with denatured alcohol all tools and other equipment that have been used. (4) If wound dressing is necessary, use gilsonite varnish in which phenylmercury nitrate has been mixed in 0.2 percent concentration (¼ ounce per gallon of gilsonite varnish). ***Phenylmercury nitrate is a highly toxic chemical—handle it with caution. Mix it with the asphalt varnish after first mulling the powder in a small quantity of linseed oil. Wipe away at once all spots of the mixture that make contact with the skin.*** (5) Insofar as is possible, restrict pruning of London plane to the period from December 1 to February 15. If trees are pruned during this period, the wounds should not be painted with a wound dressing unless the pruning tools are sterilized and the wound dressing contains phenylmercury nitrate.

Further information on canker stain is given in United States Department of Agriculture Circular 742, Canker Stain of Planetrees.

MAPLE

Anthracnose

In exceptionally wet seasons anthracnose of maple, caused by the fungus *Gloeosporium apocryptum*, sometimes causes partial defoliation. Symptoms of the disease are not the same on Norway and on sugar maple leaves. Affected leaves of the Norway maple show purple to brown narrow lines along the veins (fig. 15, *A*). Those of sugar maple show larger, irregular, green-brown or red-brown areas along and between the veins and extending to the leaf margins (fig. 15, *B*).

If this disease becomes severe enough to warrant control, burn the diseased leaves as they fall and make two or three applications of bordeaux mixture the following spring—the first when the buds are breaking and thereafter at 2-week intervals. See page 4 for information on spraying.

Black Mold

See Linden, page 26.

Bleeding Canker

A number of the hardwoods, especially the maples, are subject to bleeding canker caused by the fungus *Phytophthora cactorum*. Reddish-brown cankers develop in the inner bark of the trunk and main branches, the bark becomes furrowed and sunken, the leaves wilt, and

FIGURE 15.—*A*, Norway maple leaves affected by anthracnose show purple to brown discoloration in narrow lines along the veins. *B*, Sugar maple leaves affected by the same anthracnose fungus show large irregular green-brown or red-brown areas along and between the veins extending to the leaf margins. Both one-half natural size.

the branches die back. In maple the margins of these lesions are usually olive green. Sap oozing from these cankers through openings in the outer bark resembles small spots of blood (fig. 16)—hence the name "bleeding canker."

The removal of infected bark and the sterilization of diseased areas are less effective in the treatment of bleeding canker of maple than for many other kinds of cankers. Several research workers are experimenting with the injection of chemicals to neutralize the toxins produced by the fungus.

Leaf Blister

Leaf blister of maple is caused by several species of fungi of the genus *Taphrina*. The disease may be found on sugar, red, and silver maples, producing dark-brown circular or irregular spots, frequently near the veins, with a wrinkling of the leaf surface or a slight curling of the leaves. In spring the fruiting of the fungus produces light-colored spots on the undersurface of the leaves. Infection causes early defoliation.

Usually the injury is not severe enough to require control measures. Bordeaux mixture or sulfur sprays or dusts applied just before the buds break are effective. See page 4 for information on spraying and dusting.

Leaf Scorch

Sugar maple, beech, and ash are frequently subject to leaf scorch, a disease apparently not due to fungus attack. The trouble is generally

most prevalent following drying winds or bright sunshine after a period of moist weather but also occurs in trees not subject to such conditions. The leaves become bronzed in irregular areas, usually from the margin inward. Often certain trees seem subject to repeated attacks year after year.

In many cases the trouble may result from the inability of damaged roots or dry soil to supply enough water to keep pace with rapid transpiration. Such trees respond to a treatment that includes top pruning and improvement of the moisture-holding capacity and the fertility of the soil. Sometimes little benefit is derived from this treatment, the disease possibly being complicated by some other factor. For information on fertilizing see page 8.

FIGURE 16.—Sap oozing from bleeding cankers through openings in the outer bark of the maple looks like small spots of blood. Natural size.

Leaf Spot

Maples are subject to a number of leaf spots, one of the most common of which is caused by the fungus *Phyllosticta minima*. The spots are circular, about a quarter of an inch in diameter, reddish brown at the center, and surrounded by a pronounced purple border (fig. 17). Damage is seldom sufficient to justify the use of control measures.

Tar Spot

Tar spot, produced by the fungus *Rhytisma acerinum*, is common on leaves of red and silver maples, especially on the cutleaf varieties of the latter. The upper surfaces of affected leaves show one to several conspicuous black spots, which appear to have been made by tar-smudged fingers (fig. 18, *A*). On the lower surface of the leaves these areas are cupped and less black. A similar but more speckled tar spot is caused by the related fungus *R. punctatum* (fig. 18, *B*).

Damage caused by this disease is seldom severe enough to require treatment. If, however, control is necessary, the fallen leaves should be collected and burned.

Ustulina Butt Rot

See Elm, page 21.

White Butt Rot

White butt rot, which occasionally extends 10 feet or more upward in the trunk, is a common disease of maple, beech, birch, oak, and pop-

FIGURE 17.—Leaf spot of maple produces circular reddish-brown areas surrounded by pronounced purple borders. One-half natural size.

lar. In advanced stages of decay the wood is white to cream in color and contains fine black zone lines. Fruiting bodies of the causal fungus (*Fomes applanatus*) are probably the most common shelf form found in the Northeast. The shelves are large, thin, hard, woody, and persist from year to year. The upper surface is smooth, grayish, and zoned (fig. 19). The undersurface is white when fresh, becoming darker with age. When broken, the interior of the shelf is

FIGURE 18.—Tar spot of maple, caused (*A*) by the fungus *Rhytisma acerinum*, and (*B*) by the fungus *R. punctatum*. Both 4 times natural size.

red brown. In many cases, especially on conifers, the fungus occurs also as a saprophyte.

The sterilization of cutting tools and the use of wound dressings are effective in preventing the spread of this and other wood-destroying organisms. See page 6 for information on wound treatments.

White Mold

During moist hot weather maple leaves sometimes develop irregular grayish scorched areas, wilt, and fall (fig. 20). Close examination will reveal fruiting bodies of the fungus *Cristulariella depraedans*, usually scattered sparsely on the lower surface of the scorched areas. They resemble small round white pinheads.

Improved air circulation by thinning the planting is advisable in the control of this disease.

FIGURE 19.—Fruiting bodies of the white butt rot fungus as seen on the maple are hard, thin, and woody. The upper surface is smooth and grayish and has definite layers of growth. One-fourth natural size.

White Spongy Rot

A number of fungi cause soft white spongy rots of the heartwood and sapwood of living maples. *Hydnum septentrionale* is one of the most conspicuous forms of this group. Its fruiting bodies tend to occur on the trunks at eye level. They form large clumps of soft, watery, cream-white annual brackets (fig. 21). Examination will show that their undersurface is covered with teeth rather than with pores. In early stages the decay caused by this fungus is white surrounded by a brownish zone of discolored wood. In advanced stages the decay usually shows black zone lines at the margins.

The fungus usually enters through unprotected pruning wounds or similar openings in the bark. Such wounds should be treated in accordance with directions on page 6.

Another common fungus causing white spongy rot of maple is *Fomes connatus*. Its fruiting bodies are less conspicuous, smaller, and less clumped than those just described. Generally the upper surface is covered by a coating of green moss. The fruiting body or conk is bracketlike and lives from year to year, as indicated by layers of growth evident when it is cut or broken. The white to yellow brackets

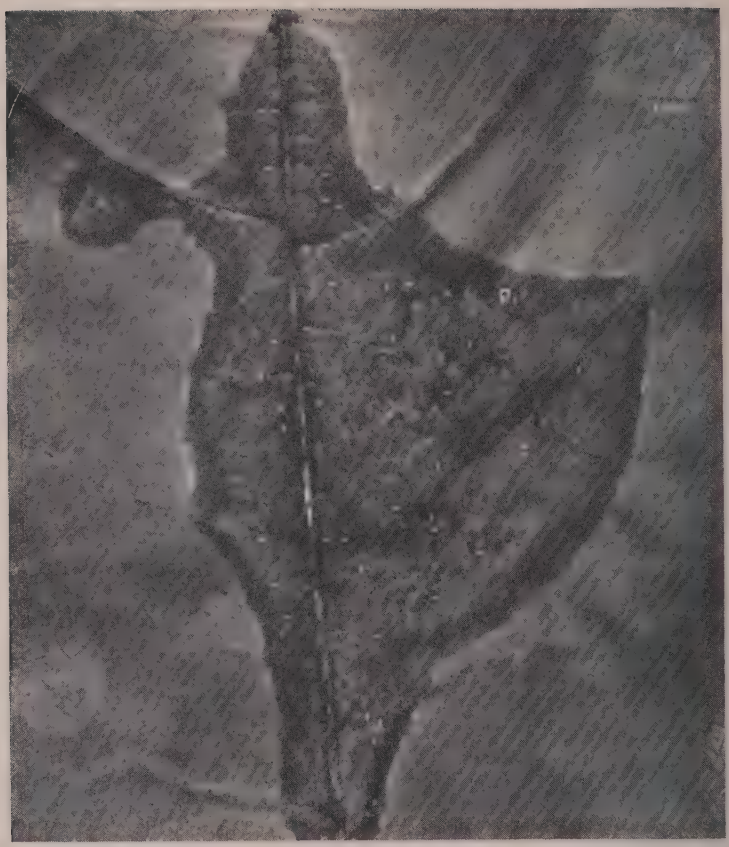

FIGURE 20.—Irregular grayish scorched areas on the undersurface of a maple leaf. The fruiting bodies of the causal fungus resemble small white pinheads. Four times natural size.

are somewhat hoof-shaped and of corky texture. The pores, which occur on the lower surface, are small (fig. 22).

Although this decay-producing fungus also enters unprotected branch stubs, it is probably one of the most common forms to attack the tree through open frost cracks. For this reason the dressing of frost cracks that do not close promptly is advisable in addition to the usual wound treatment.

Wilt

Wilt, caused by a species of the fungus *Verticillium*, is a destructive disease of most species of maple. It is characterized by a sudden wilting and dying of the leaves of one or more branches or limbs. Pronounced greenish streaks in the sapwood indicate the presence of the disease (fig. 23). Frequently such discoloration occurs at a considerable distance from the wilting foliage and for that reason is difficult to locate. Elm and ailanthus also are susceptible.

Immediate pruning to remove the infected branches is recommended for the treatment of mild cases. Sterilize the cutting tools used in this work. If possible use fertilizers liberally to stimulate growth. The treatment of badly infected trees is not recommended. They shoud be removed. See pages 6 and 8 for information on sterilizing tools and on fertilizing.

MIMOSA

Wilt

Wilt of the mimosa is caused by the fungus *Fusa-*

FIGURE 21.—White spongy rot, caused by the wood-decaying fungus *Hydnum septentrionale*, forming large clumps of soft, watery, cream-white brackets that rot the heartwood and sapwood of living maples. One-tenth natural size.

FIGURE 22.—White spongy rot of maple, caused by the wood-decaying fungus *Fomes connatus*, forming clumps of corky brackets with small pores on the lower surfaces (right). Moss, as shown in the illustration, generally covers the upper surfaces (left). Two-thirds natural size.

FIGURE 23.—Pronounced greenish streaks in the sapwood indicate the presence of maple wilt. Natural size.

rium oxysporum f. *perniciosum*. The tree has been found to be susceptible to wilt in Maryland, Virginia, North Carolina, South Carolina, and Georgia. The leaves wilt and droop, becoming dry and shriveled. Early defoliation then takes place and the tree dies, usually within a year after the first wilting is noticeable. A ring of brown discolored sapwood is present in the trunks, roots, and branches of infected trees. As the fungus is capable of living in the ground, do not use soil from infected areas in localities where the disease does not occur.

In a diseased area no method has been found to prevent the spread of wilt from tree to tree. In plantings, mimosa trees should be replaced by other species that are resistant to wilt. A detailed description of the disease and its control is given in United States Department of Agriculture Circular 535, A Vascular Wilt of the Mimosa Tree (*Albizzia julibrissin*).

OAK

Anthracnose

Anthracnose of oak is caused by the fungus *Gnomonia veneta*. Several species of oak are attacked, but damage is most severe on white oak. Premature defoliation is common in wet seasons. Diseased leaves show small scattered brown spots (fig. 24, *A*) or large brown areas that tend to follow the veins to the margin (fig. 24, *B*). Twigs also are attacked but are not seriously damaged.

Three applications of bordeaux spray will ordinarily control the disease. Make the first application when the buds burst and later ones at intervals of 10 days to 2 weeks. Sanitation pruning also is beneficial. All dead or cankered twigs should be carefully pruned out and burned. See pages 4 and 6 for information on spraying and pruning.

FIGURE 24.—Anthracnose fungus has caused (*A*) the scattered spots on this red oak leaf (one-half natural size) and (*B*) the large brown areas that tend to follow the veins to the margins of these white oak leaves. One-fourth natural size.

Basal Canker

The fungus *Phaeobulgaria inquinans* (also referred to as *Bulgaria inquinans*) fruits freely on oaks in the crevices of sunken bark that often overlies basal cankers (fig. 25). Infection starts in open wounds. Once established the fungus may invade the surrounding bark and sapwood and eventually kill the tree by girdling. The mature fruiting bodies are more or less cup- or saucer-shaped and grow from short stemlike bases that extend into the bark. The outside of the cup is dark brown and rough, the inside black. When moist these fruiting bodies look and feel like rubber. They vary greatly in size—one-eighth to 1 inch, or even larger, in diameter.

In treating basal canker, remove and burn the infected bark and sapwood and treat the wound as advised in the section on Wound Treatment, page 6.

Brown-Checked Wood Rot

Oak is much subject to decay. One of the more common fungi causing rot of oak heartwood is *Polyporus sulphureus*, which also attacks numerous other trees. It forms large clumps of brackets that are soft, fleshy, and conspicuously sulfur-colored when fresh (fig. 26). Older brackets have a chalklike color and texture. The pores are small. The rot produced by this fungus is a brown charcoallike substance that splits into cubes.

Prevent unnecessary wounding as far as possible, and protect pruning cuts by a wound dressing. See page 6 for wound treatment.

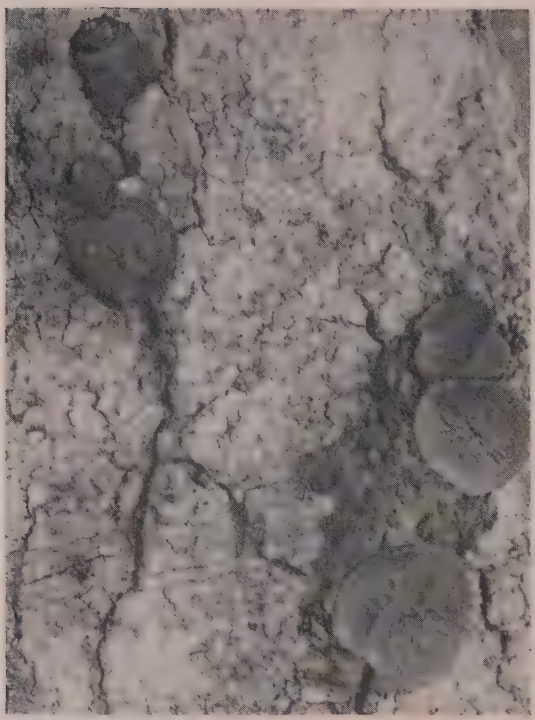

FIGURE 25.—The causal fungus of basal cankers of oak fruits freely in the crevices of the sunken bark that overlies them. Natural size.

Leaf Blister

Leaf blister, also known as blister blight and leaf curl, is caused by the fungus *Taphrina coerulescens*. Raised and slightly wrinkled yellowish circular areas appear on the upper surfaces of diseased leaves (fig. 27). On the lower surfaces these lesions are depressed. A similar disease is found occasionally on birch leaves.

In the North, leaf blister rarely causes more than slight defoliation, but in the

FIGURE 26.—Wood-decaying fungus that forms large clumps of bracketlike fruiting bodies that are sulfur-colored when fresh. It causes brown-checked wood rot in oaks and attacks many other trees. One-third natural size.

South it may be more severe. Lime sulfur or bordeaux mixture, used as a dormant spray late in fall after the leaves have fallen or early in spring before the buds open, has been recommended as a control for this disease. For precautions to be observed when lime sulfur spray is used, see page 5.

Shoestring Root Rot

Many kinds of trees, especially oaks, are subject to a rotting of the bark and wood of the roots and root collar, caused by the fungus *Armillaria mellea*. The fruiting bodies of the fungus are honey-colored to light-brown mushrooms with scaly tops (fig. 28). They

FIGURE 27.—Leaf blister on white oak is frequently serious in the South. Natural size.

generally appear late in summer or in fall. Black rootlike strands under the bark of the trunk and on the roots are characteristic of the organism (fig. 29). The virulence of this fungus appears to vary widely. At times it seems to be parasitic; in most cases, however, it is probably secondary, following injury.

Vigorous trees appear to be attacked less frequently than poorly growing ones. For maximum protection against this disease maintain soil fertility (see p. 8), provide adequate water if needed during dry

FIGURE 28.—The fruiting bodies of the fungus causing root rot on oak and other trees are honey-colored to light-brown mushrooms with scaly tops. One-fifth natural size.

periods, and avoid injuries to the roots as far as possible. If earth fills have been made above the roots, pipes should be installed to admit air to the original soil level. For further information on the construction of wells around trees when fills are to be made and on the installation of tile to admit air to the original soil level, see Farmers' Bulletin 1967, Reducing Damage to Trees from Construction Work.

Strumella Canker

The canker caused by the fungus *Strumella coryneoidea* is generally troublesome only in forest trees, but is occasionally found on ornamentals. Although a number of species are attacked, the disease is most common on oak, producing on the trunk sunken cankers (fig. 30) that grow to large size and cause distortion. They tend to be longer than they are wide and in some cases show targetlike ridges on the surface.

Cankers sometimes can be cut out and treated as open cavities or wounds. In making improvement cuttings in ornamental woodlands, remove affected trees.

Twig Canker

Twig canker attacks numerous species of oak but is generally most severe on the chestnut oak. It is caused by the fungus *Diplodia longispora* (also frequently referred to as *Sphaeropsis quercina*). Twigs and small branches are killed, and the leaves die and tend to stick to the twigs. When cut into, the sapwood shows pronounced black streaks. Black fruiting bodies smaller than the head of a pin occur in the dead bark.

Control the disease by pruning and burning the diseased twigs and small branches. This work can usually be done most effectively in summer, but the treatment should be repeated early the following spring to remove deadwood.

Wilt

Wilt, caused by the fungus *Chalara quercina*, is an important disease of oaks in the upper Mississippi Valley. Red and black oaks are par-

FIGURE 29.—Black mycelial strands are characteristic of the shoestring root rot fungus. The strands are sometimes mistaken for roots. Natural size.

FIGURE 30.—Sunken strumella canker on oak. One-twelfth natural size.

ticularly susceptible, and the rapid wilting of the leaves is soon followed by the death of the tree. Scarlet, white, and bur oaks are attacked but seem to be more resistant. Mature leaves become bronze or brown along the margins, and the discoloration gradually progresses toward the midrib and base. Premature fall of affected leaves may occur. Young leaves become blackened and droop conspicuously but remain attached after wilting. A brown or black discoloration of the sapwood is sometimes present in diseased trees.

Control or preventive methods have not been thoroughly tested. Where practicable, however, remove the diseased trees immediately and burn the debris from them. Do not pile the wood in the open near other oaks.

PERSIMMON

Wilt

Wilt of the persimmon tree, which is caused by the fungus *Cephalosporium diospyri*, is important in Tennessee, Georgia, Florida, North Carolina, and South Carolina and occurs also in a few localities in Mississippi and Alabama. The Japanese persimmon is more resistant than the American but may be killed if grafted on American stock. Wilting and yellowing of the leaves at the tops of infected trees occur in spring, followed by defoliation in summer. Brownish-black streaks are present in the wood, and the salmon-colored spores of the fungus are found just below the loosened bark.

No effective control measures can be recommended.

PINE

Black Mold

See Linden, page 26.

Needle Blight

Needle blight of pine is not caused by a parasitic organism. The symptoms are very similar to those of needle cast. Eastern white pine is most commonly affected. The tops, or more rarely entire needles, of the current season's growth turn reddish brown late in spring but remain on the tree for some time. There is no further spread of the injury during the growing season and the exact cause is unknown. An inadequate root system, injury to the small feeding roots, or poor soil conditions seem to be the cause.

Fertilizing (see p. 8) and watering during drought are sometimes beneficial.

Needle Cast

Many of the pines, particularly red, eastern white, and pitch, are susceptible to needle cast, which is caused by various species of the fungi *Hypoderma* and *Lophodermium*. Occasional reddish-brown needles or parts of needles bearing small shiny black oval spots in the discolored areas indicate the presence of these fungi (fig. 31). Affected needles may fall prematurely, but the extent of defoliation is usually so slight that except in young nursery trees no serious injury results. For this reason control measures are rarely necessary.

Needle Rust

One of the most widespread of the needle rusts that attack pines and one that is common on a number of species, particularly on pitch and

red pines, is caused by the fungus *Coleosporium solidaginis*. Goldenrods and asters, which also are attacked by it, are known as its alternate hosts. In spring conspicuous pustules about one-eighth of an inch in length appear on infected pine needles (fig. 32). These are baglike and contain orange-colored spores. This rust seldom does great damage, but occasionally heavy infections cause considerable defoliation. If control is desired, destroy the goldenrods and wild asters growing in the vicinity.

Red-Brown Butt Rot

Pines, Douglas-firs, and spruces are frequently attacked by the fungus *Polyporus schweinitzii*. It causes a butt and root rot known as red-brown butt rot. Its attack weakens the trees and makes them easily blown down in high winds.

FIGURE 31.—The small black oval spots on this white pine needle were produced by needle cast fungus. Eight times natural size.

FIGURE 32.—Needle rust blisters dot the leaves of this red pine. One-half natural size.

Wood decayed by this fungus is yellowish to red brown, tends to break into large cubes when dried, and becomes so brittle that it is easily crumbled to dust.

The fruiting bodies of the fungus appear late in summer or in fall during wet weather. They may be found both on the butts of infected trees and coming up through the ground from diseased roots, both in bracket and in more or less circular forms with stems. The caps are usually grouped closely together in overlapping growth. Viewed from above, these caps are velvety and reddish brown with yellow-brown margins. The undersurface is green brown and has large irregular pores.

Infection by this fungus is frequently through wounds, especially fire scars, at the base of the trunk. Since control is not feasible where decay becomes extensive, avoid wounding wherever possible and apply promptly protective dressings to wounds that cannot be avoided. See page 6 for further information on wound treatments.

Tip Blight

Hard pines, particularly Scotch, Austrian, and other introduced species, are susceptible to tip blight, caused by the fungus *Diplodia pinea*. Scattered needles of the current season's growth or all the needles of a young twig may turn brown early in spring before reaching maturity and may remain stunted (fig. 33). The small black fruiting bodies of the fungus may be found in summer at the base of the affected needles, and excessive resin flow occurs from infected twigs. The disease disfigures and weakens the tree.

Affected twigs should be pruned out and burned. Apply a 4–4–50 bordeaux spray early in spring when the buds begin to open and again in about 2 weeks. See page 5 for information on bordeaux mixture.

White Pine Blister Rust

White pine blister rust is caused by the fungus *Cronartium ribicola*. Any pine that has five needles in a fascicle (bundle or cluster), a distinguishing characteristic of all white pines, may become infected by this fungus, but the eastern and western white pines and the sugar pine are particularly susceptible. Cankers girdle the branches or trunk of a pine tree and cause the death of the affected parts or the entire tree.

Infection takes place in the leaves, and the fungus grows from them into the bark, forming a canker in which blisters containing orange-colored spores are produced.

Spores of the fungus formed on the pine do not infect pines but do infect currants and gooseberries. Spores of the fungus produced on the diseased bushes then infect pines. The disease spreads among pines only when currants or gooseberries are present.

The most common method of control is to destroy the shrubs in the vicinity of the pines. Infected pines that are of considerable value may sometimes be saved by pruning out diseased branches and removing the infected bark of stem cankers. This process is described in detail in Farmers' Bulletin 1885, Treatment of White Pines Infected with Blister Rust.

Winter Injury

Winter injury is shown by extensive browning of the previous season's needles. See Arborvitae, page 10.

FIGURE 33.—Stunting and browning of the needles of the two small side branches of this pine shoot were caused by tip blight. One-half natural size.

PLANETREE

See Sycamore and London Planetree, pages 48 and 27.

POPLAR

Cytospora Canker

Aspen, cottonwood, white poplar, and willow are susceptible to a canker disease caused by *Cytospora chrysosperma*, but the Rio Grande cottonwood in the West is resistant. Trees lacking in vigor are most frequently attacked. The cankers occur on trunks and large branches. Infection in small branches and twigs results in dieback without definite cankers. Diseased bark becomes discolored, and the sapwood is reddish brown and water-soaked. Old cankers may have exposed wood surrounded by layers of callus tissue. Yellowish or red-brown tendrils containing spores of the fungus exude in moist spring weather from small pustules in the diseased bark.

FIGURE 34.—Lombardy poplars affected by Dothichiza canker.

Growing conditions should be improved and wounding should be avoided. If infected twigs are pruned out, all cut surfaces should be carefully protected from infection and pruning tools should be sterilized. See page 6 for information on pruning and the protection of cut surfaces.

Dothichiza Canker

Dothichiza canker, caused by the fungus *Dothichiza populea*, attacks various species of cottonwood and poplar, but Lombardy poplar is most susceptible (fig. 34). Cankers are formed on trunks, twigs, and branches, particularly around wounds on young trees. The bark becomes darkened and cracked, and callus tissue forms in old cankers. Water sprouts may develop below the affected area but soon become infected and die.

All seriously diseased trees should be destroyed. Prune out and burn branches with small cankers on newly infected trees. Carefully sterilize tools used in pruning. For methods of wound treatment see page 6.

Leaf Spot

Leaf spot caused by fungi of the genus *Marssonia* occurs particularly on white and Lombardy poplars and on cottonwoods. Spots are usually more conspicuous on the upper leaf surface and at first are small, reddish brown with a dark margin, and circular. They may increase in size until most of the leaf is affected and early defoliation takes place.

Control for this disease is rarely necessary.

Similar leaf spots are sometimes caused by other fungi, such as species of *Septoria*, but none of these causes serious injury.

Scab

Scab on poplar, which is very similar to scab on willow, is caused by the fungus *Didymosphaeria populina*. Young leaves and some-

times entire young shoots are blackened and wilted. Under moisture conditions favorable for the growth of the fungus, dark olive-green masses of spores are produced on the leaves.

Injury from the disease is not extensive enough to require control.

REDBUD

Canker

Canker caused by the fungus *Botryosphaeria ribis* has been found on redbud in Connecticut, New Jersey, Delaware, Maryland, the District of Columbia, Virginia, and North Carolina. The cankers begin as small sunken areas, usually at the base of twigs, although trunk cankers sometimes occur, and increase slowly in size. The bark becomes blackened in the center of the cankers and finally cracks along the margins with the formation of callus tissue. Underlying wood is discolored. The slowly growing canker may eventually girdle the branch, causing its death. This disease sometimes attacks willows.

As infection takes place through wounds, control consists principally in their prevention and protection. Carefully sterilize all tools used in pruning. For further information on protection of pruning wounds see page 6.

REDCEDAR

Blight

Blight, or cedar blight, is caused by the fungus *Phomopsis juniperovora*. It is essentially a disease of nursery trees but may carry over to larger ornamentals. Redcedar is most susceptible, but the disease is found occasionally on other ornamental junipers and cedars. It is fairly well distributed in most of the States east of the Mississippi. The fungus forms small brown cankers or lesions on the young twigs (fig. 35), causing the eventual girdling and a dieback of the tips (fig. 36). Sometimes parts of trees or entire small trees may be killed. Similar symptoms may result from injury by drought or winterkilling, and therefore laboratory tests are usually necessary for an exact diagnosis.

FIGURE 35.—Young twig of redcedar cankered by blight. Spore horns of the causal fungus appear as twisted tendrils. Twice natural size.

Where infection is slight, diseased parts should be pruned out and the trees sprayed with 4–4–50 bordeaux mixture, to which a spreader has been added. See page 5 for instructions on the use of bordeaux mixture. Spray at intervals of 2 weeks throughout the growing season. Destroy dead branches and trees.

Cedar-Apple Rust

Cedar-apple rust is caused by the fungus *Gymnosporangium juniperi-virginianae*. This fungus spreads from the redcedar to certain

FIGURE 36.—Dieback of the tips of redcedar branch caused by blight. Natural size.

species of ornamental and orchard apples and on them produces spores that can infect cedar. The presence of both apples and redcedars is necessary for continual spread of the disease. On the redcedar the rust fungus forms brown globoid galls covered with slender spore horns (fig. 37, *A*), which in moist spring weather swell into jellylike orange-colored spore masses (fig. 37, *B*). From these spores small secondary spores are produced, which are borne by the wind and are capable of infecting species of apple. A few weeks after infection, yellow spots appear on the upper surface of the apple leaves and sometimes on the fruits. These develop small black pustules, and later in the season orange-colored, cup-shaped cushions are formed on the lower surface of the spots. A different type of spore is produced in each of these

two fruiting structures, and the second type is wind-borne late in summer or early in fall to susceptible redcedars. Evidence of infection begins to appear the following summer, but the galls do not mature until the second season after infection. The disease causes a premature defoliation of apple trees and the slow death of redcedar twigs.

For control measures, see Cedar-Hawthorn Rust.

Cedar-Hawthorn Rust

Cedar-hawthorn rust, caused by the closely related fungus *Gymnosporangium globosum*, also forms galls on redcedar. These are somewhat smaller and a deeper red than those produced by the cedar-apple rust and are perennial rather than annual and the spore horns are shorter and flatter (fig. 38). The hawthorn is the principal alternate host of this fungus, but apple, pear, and mountain-ash are also attacked.

Control of cedar-hawthorn rust and cedar-apple rust is best accomplished by not growing ordinary redcedars, hawthorns, and the various forms of apple in the same neighborhood. The West Virginia Agricultural Experiment Station has discovered and propagated a rust-resistant strain of redcedar.

When the disease is troublesome in established redcedar plantings, a single spring application of 4–4–50 bordeaux spray containing a

FIGURE 37.—*A*, On redcedar the cedar-apple rust fungus produces brown globoid galls covered with slender spore horns. *B*, The galls of cedar-apple rust swell into jellylike orange-colored spore masses during moist spring weather. Both natural size.

FIGURE 38.—The spore horns of the cedar-hawthorn rust fungus on redcedar trees are shorter and flatter than those produced by the cedar-apple rust fungus. Natural size.

spreader will give partial control. This should be applied when the spore horns of the fungus first swell. For further information on spraying see page 4.

SPRUCE

Canker

Canker caused by the fungus *Cytospora kunzei* is especially common on Norway and blue spruces, killing back the branches, particularly those at the base of the tree (fig. 39). A large flow of resin on living branches is the earliest and most noticeable symptom (fig. 40).

Prune out and burn affected branches. For information on pruning see page 6.

Dieback

The tops of large specimens of Norway spruce frequently die back (fig. 41), mostly because, being heavy feeders, the trees have impoverished the soil in which they grow.

The application of fertilizers is generally beneficial if undertaken promptly when weakening of top growth becomes apparent. For information on fertilizing see page 8.

SYCAMORE

Anthracnose

Anthracnose, or blight, a disease of leaves and twigs of sycamore (buttonball), is caused by the fungus *Gnomonia veneta.* Severe de-

FIGURE 39.—Canker has killed back these spruce branches. One-third natural size.

foliation of native sycamores is common, but affected trees normally produce a second crop of leaves within 2 weeks to 1 month. Damage is considerable, however, because the excessive number of short twigs spoils the shape of the trees and repeated defoliation in successive years weakens them. The first symptoms of the disease resemble injury by late frost. Later, brown areas fleck the leaf irregularly or follow the veins to the leaf margin. The fungus kills the tips of the twigs and causes cankers on the branches.

The London planetree has long been recognized as resistant to the disease, and for that reason it has been used extensively in municipal planting.

All dead or cankered wood should be carefully pruned out and burned. If the disease tends to recur year after year, three applications of bordeaux mixture are recommended. Apply the first before the buds break, the second just after they break, and the third when the leaves are half-grown. During wet seasons at least one additional spraying may be necessary 10 days after the third application. For information on bordeaux mixture see page 5.

FIGURE 40.—Excessive resin flow is characteristic of spruce canker. Slightly less than natural size.

TAMARACK

See Larch, page 24.

TREE-OF-HEAVEN

See Ailanthus, page 9.

TULIPTREE

(Also known as yellow-poplar.)

Black mold

See Linden, page 26.

WILLOW

Botryosphaeria Canker

Botryosphaeria canker, which sometimes attacks willows, especially pussy willow, is described under redbud, page 45.

Crown Gall

Crown gall, caused by the bacterium *Agrobacterium tumefaciens*, frequently occurs on willows but does little damage to the larger trees. Roughened swellings varying greatly in size are produced on the roots and trunks or on the branches. The appearance of the trees can be improved by removing the galls.

No further control measures are recommended.

FIGURE 41.—Dieback of the tops of large Norway spruce trees. This condition is frequently attributable to soil impoverishment.

Cytospora Canker

See Poplar, page 43.

Scab

Scab caused by the fungus *Fusicladium saliciperdum* is a destructive disease of willows in the Northeastern States (fig. 42). Although relatively new to this section, it has killed thousands of trees, largely because of their inability to withstand repeated defoliation. To the casual observer the disease does not appear serious in its early stages, but in later stages its seriousness is readily apparent.

Early in spring scattered leaves at the tips of the branches blacken and die. During wet seasons this infection spreads rapidly through the tree—the leaves blacken, twigs are attacked, and olive-green patches of feltlike spore masses can be seen along the veins on the under side of the leaves. Most of the damage occurs in spring.

Four or five treatments with bordeaux mixture or dry lime-sulfur (3–50) are recommended for the control of the disease. Apply the first of these while the trees are still dormant, just before the buds break, the second on the unfolding buds, the third when the leaves are half-grown, and the fourth when the leaves are nearly full-grown. Apply a fifth spray, if necessary, 10 days later. Such a schedule calls for crowding treatments into a period between the middle of April and the early

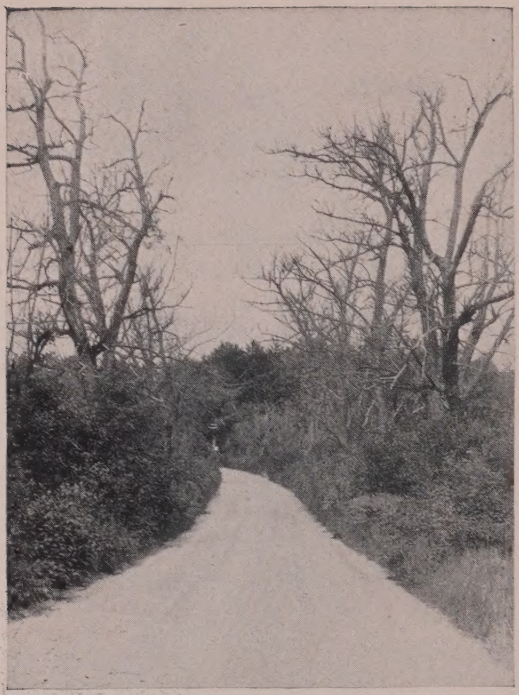

FIGURE 42.—Dead willows beside a New England road. Willow scab fungus has killed many such trees in the Northeastern States.

The upper surface is velvety to the touch and the lower feels like chamois skin. The pores are large in mature specimens. A chief characteristic of this fungus is its anise-like odor. Wood rotted by this fungus is white, dry, and corky to punky in texture.

The disease produced by this fungus seems most destructive to willows that have been subjected to much breakage, improper pruning, or other forms of wounding. Care to avoid injury is important in preventing the spread of the disease to part of June. Ordinarily the rest of the season is not cool and wet enough to make conditions favorable for the further spread of the disease. For precautions to be observed when lime-sulfur sprays are used and for other information on spraying see page 4.

White Wood Rot

White wood rot of willow is caused by the fungus *Trametes suaveolens*, fruiting bodies of which are common on both living and dead trees (fig. 43). They are bracket forms about 4 inches broad, projecting 3 or 4 inches from the tree trunk, and tending to overlap. They are corky in texture and white to gray in color.

FIGURE 43.—Fruiting bodies of white wood rot fungus on a living willow. One-sixth natural size.

healthy trees. Wounds should be treated as advised in the section on Wound Treatment, page 6.

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